Claims

1. A simulation method which predicts the distribution of the amount of polishing of the polished surface of an object of polishing after this object of polishing has been polished by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this simulation method being characterized by the fact that a step which predicts the amount of polishing in individual partial regions of the polished surface of the above-mentioned object of polishing following the polishing of this object of polishing includes an indicator which indicates the height distribution of the polishing surface of the above-mentioned polishing body with reference to the above-mentioned substrate when no pressure is applied to this polishing body, as one of the parameters used in the calculations performed in this step, and

the above-mentioned indicator is one indicator or a combination of two or more indicators selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

2. The simulation method according to Claim 1, which is characterized by the fact that the above-mentioned height distribution of the above-mentioned polishing body is successively predicted on the basis of the above-mentioned indicator during the time of use of the above-mentioned polishing body, and the amount of polishing in the above-mentioned partial regions is predicted on the basis of the most recently predicted height distribution.

3. The simulation method according to Claim 2, which is characterized by the fact that the prediction of the above-mentioned height distribution is performed following a dressing process that dresses the above-mentioned polishing body.

4. The simulation method according to Claim 2, which is characterized by the fact that the prediction of the above-mentioned height distribution is performed after a polishing process is performed by the above-mentioned polishing body on an object of polishing that is different from the above-mentioned object of polishing.

5. The simulation method according to Claim 2, which is characterized by the fact that the prediction of the above-mentioned height distribution is accomplished by referring to a look-up table or equation which shows the relationship between the above-mentioned height distribution and one parameter or a combination of two or more parameters selected from a set comprising the number of times that a

dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

6. The simulation method according to Claim 2, which is characterized by the fact that the prediction of the above-mentioned height distribution is performed in accordance with the equation of Preston.

7. The simulation method according to Claim 1, which is characterized by the fact that the polishing of the above-mentioned object of polishing is chemical mechanical polishing which is performed with a polishing agent interposed between the above-mentioned polishing body and the above-mentioned object of polishing.

8. A simulation method which predicts the shape of the polished surface of an object of polishing or the film thickness distribution on the side of the above-mentioned polished surface after the above-mentioned object of polishing has been polished by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this simulation method being characterized by the fact that the above-mentioned shape or the above-mentioned film thickness distribution of the above-mentioned object of polishing is predicted using the simulation method according to Claim 1.

9. A control parameter or control program preparation method which prepares control parameters or a control program used to control a polishing apparatus which polishes an object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this control parameter or control program preparation method being characterized by the fact that the method comprises

a simulation stage in which the distribution of the amount of polishing of the above-mentioned polished surface (that is obtained after the above-mentioned object of polishing has been polished by the above-mentioned polishing apparatus) is predicted according to assumed or set control parameters or an assumed or set control program using the simulation method according to Claim 1, and

a judgement stage in which the acceptability of the above-mentioned assumed or set control parameters or control program is judged by comparing the distribution of the amount of polishing predicted in the above-mentioned simulation stage and a target distribution of the amount of polishing of the polished surface of the above-mentioned object of polishing.

10. The control parameter or control program preparation method according to Claim 10, which is characterized by the fact that in cases where a judgement of "unacceptable" is made in the above-mentioned judgement stage, the above-mentioned assumed or set control parameters or control program are changed to control parameters or a control program which are altered at least in part with respect to the control parameters or control program already judged to be "unacceptable" in the above-mentioned judgement stage, and the above-mentioned simulation stage and above-mentioned judgement stage are repeated in that order until the control parameters or control program obtained are judged to be "acceptable."

11. A simulation apparatus which predicts the distribution of the amount of polishing of the polished surface of an object of polishing after this object of polishing has been polished by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this simulation apparatus being characterized by the fact that the apparatus has prediction means for predicting the amount of polishing in individual partial regions of the polished surface of the above-mentioned object of polishing following the polishing of this object of polishing, these prediction means use an indicator which indicates the height distribution of the polishing surface of the above-

mentioned polishing body with reference to the above-mentioned substrate when no pressure is applied to this polishing body, as one of the parameters used in the calculations performed by these prediction means, and

the above-mentioned indicator is one indicator or a combination of two or more indicators selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

12. The simulation apparatus according to Claim 11, which is characterized by the fact that the apparatus further comprises means for successively predicting the above-mentioned height distribution of the above-mentioned polishing body on the basis of the above-mentioned indicator during the time of use of this polishing body, and the above-mentioned prediction means predict the amount of polishing in the above-mentioned partial regions on the basis of the most recently predicted height distribution.

13. The simulation apparatus according to Claim 12, which is characterized by the fact that the above-mentioned means for predicting the above-mentioned height

distribution perform the prediction of the above-mentioned height distribution following a dressing process that dresses the above-mentioned polishing body.

14. The simulation apparatus according to Claim 12, which is characterized by the fact that the above-mentioned means for predicting the above-mentioned height distribution perform the prediction of the above-mentioned height distribution following a polishing process performed by the above-mentioned polishing body on an object of polishing that is different from the above-mentioned object of polishing.

15. The simulation apparatus according to Claim 12, which is characterized by the fact that the above-mentioned means for predicting the above-mentioned height distribution perform the prediction of the above-mentioned height distribution by referring to a look-up table or equation which shows the relationship between the above-mentioned height distribution and one parameter or a combination of two or more parameters selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

16. The simulation apparatus according to Claim 12, which is characterized by the fact that the above-mentioned means for predicting the above-mentioned height distribution perform the prediction of the above-mentioned height distribution according to the equation of Preston.

17. The simulation apparatus according to Claim 11, which is characterized by the fact that the polishing of the above-mentioned object of polishing is chemical mechanical polishing which is performed with a polishing agent interposed between the above-mentioned polishing body and the above-mentioned object of polishing.

18. A simulation apparatus which predicts the shape of the polished surface of an object of polishing or the film thickness distribution on the side of the above-mentioned polished surface after the above-mentioned object of polishing has been polished by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body, this simulation apparatus being characterized by the fact that the apparatus comprises prediction means for predicting the above-mentioned shape or the above-mentioned film thickness distribution of the above-mentioned object of polishing using the simulation method according to Claim 1.

19. A simulation apparatus which predicts the shape of the polished surface of an object of polishing or the film thickness distribution on the side of the above-mentioned polished surface after the above-mentioned object of polishing has been polished by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body, this simulation apparatus being characterized by the fact that the apparatus comprises prediction means for predicting the above-mentioned shape or the above-mentioned film thickness distribution of the above-mentioned object of polishing using the simulation apparatus according to Claim 11.

20. A control parameter or control program preparation apparatus which prepares control parameters or a control program used to control a polishing apparatus which polishes an object of polishing by causing relative motion between this object of polishing and a polishing tool which has a polishing body and a substrate that supports the surface of this polishing body on the side opposite the polishing surface while applying a load between the above-mentioned object of polishing and the above-mentioned polishing body of the above-mentioned polishing tool,

this control parameter or control program preparation apparatus being characterized by the fact that the apparatus comprises simulation means for predicting the distribution of the amount of polishing of the above-mentioned

polished surface (that is obtained after the above-mentioned object of polishing has been polished by the above-mentioned polishing apparatus) according to assumed or set control parameters or an assumed or set control program using the simulation method according to Claim 1, and

judgement means for judging the acceptability of the above-mentioned assumed or set control parameters or control program by comparing the distribution of the amount of polishing predicted by the above-mentioned simulation means and a target distribution of the amount of polishing of the polished surface of the above-mentioned object of polishing.

21 The preparation apparatus according to Claim 22, which is characterized by the fact that the apparatus comprises means which change the above-mentioned assumed or set control parameters or control program to control parameters or a control program that are altered at least in part with respect to the control parameters or control program already judged to be "unacceptable" by the above-mentioned judgement means in cases where a judgement of "unacceptable" is made in the above-mentioned judgement stage, and which cause the above-mentioned simulation means and the above-mentioned judgement means to repeat their operation in that order until the control parameters or control program obtained are judged to be "acceptable."

22. A method for polishing an object of polishing using a polishing apparatus which polishes this object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body, this polishing method being characterized by the fact that the above-mentioned object of polishing is polished by operating the above-mentioned polishing apparatus in accordance with control parameters or a control program prepared by the control parameter or control program preparation method according to Claim 9.

23. A method for polishing an object of polishing using a polishing apparatus which polishes this object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body, this polishing method being characterized by the fact that the above-mentioned object of polishing is polished by operating the above-mentioned polishing apparatus in accordance with different control parameters or a different control program according to an indicator which indicates the height distribution of the polishing surface of the above-mentioned polishing body with reference to the above-mentioned substrate when no pressure is applied to this polishing body, and

the above-mentioned indicator is one indicator or a combination of two or

more indicators selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

24. A polishing apparatus which polishes an object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body, this polishing apparatus being characterized by the fact that the above-mentioned object of polishing is polished in accordance with control parameters or a control program prepared by the control parameter or control program preparation method according to Claim 9.

25. A polishing apparatus which polishes an object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this polishing apparatus being characterized by the fact that the apparatus comprises control means for controlling the operation of the above-mentioned

polishing using different control parameters or in accordance with a different control program according to an indicator which indicates the height distribution of the polishing surface of the above-mentioned polishing body with reference to the above-mentioned substrate when no pressure is applied to this polishing body, and

the above-mentioned indicator is one indicator or a combination of two or more indicators selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

26. The polishing apparatus according to Claim 24, which is characterized by the fact that the polishing of the above-mentioned object of polishing is chemical mechanical polishing which is performed with a polishing agent interposed between the above-mentioned polishing body and the above-mentioned object of polishing.

27. A computer-readable recording medium on which a program is recorded that is used to realize in a computer a simulation function that predicts the distribution of the amount of polishing of the polished surface of an object of polishing after this object of polishing has been polished by causing relative motion between this object

of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this computer-readable recording medium being characterized by the fact that the above-mentioned simulation function simulates the amount of polishing in individual partial regions of the polished surface of the above-mentioned object of polishing following the polishing of this object of polishing, this function includes a function that simulates the amount of polishing using an indicator which indicates the height distribution of the polishing surface of the above-mentioned polishing body with reference to the above-mentioned substrate when no pressure is applied to this polishing body, as one of the parameters used in the calculations performed by this function, and

the above-mentioned indicator is one indicator or a combination of two or more indicators selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

28. A computer-readable recording medium on which a program is recorded that is used to realize in a computer a simulation function that predicts the shape of the

polished surface of an object of polishing or the film thickness distribution on the side of the above-mentioned polished surface after this object of polishing has been polished by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this computer-readable recording medium being characterized by the fact that the above-mentioned simulation function is a function which calculates the amount of polishing in individual partial regions of the polished surface of the above-mentioned object of polishing following the polishing of this object of polishing, this function includes a function that performs calculations using an indicator which indicates the height distribution of the polishing surface of the above-mentioned polishing body with reference to the above-mentioned substrate when no pressure is applied to this polishing body, as one of the parameters used in the calculations performed by this function, and

the above-mentioned indicator is one indicator or a combination of two or more indicators selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

29. A computer-readable recording medium on which a program is recorded that is used to cause a computer to execute control parameter or control program preparation processing that prepares control parameters or a control program used to control a polishing apparatus that polishes an object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body,

this computer-readable recording medium being characterized by the fact that the above-mentioned control parameter or control program preparation processing includes (a) a simulation stage in which the distribution of the amount of polishing of the above-mentioned polished surface (that is obtained after the above-mentioned object of polishing has been polished by the above-mentioned polishing apparatus) is predicted in accordance with assumed or set control parameters or an assumed or set control program, and (b) a judgement stage in which the acceptability of the control parameters or control program assumed in the above-mentioned assuming stage is judged by comparing the distribution of the amount of polishing predicted in the above-mentioned simulation stage with a target distribution of the amount of polishing of the polished surface of the above-mentioned object of polishing,

the above-mentioned simulation stage includes a stage in which the amount of polishing in individual partial regions of the polished surface of the above-

mentioned object of polishing following the polishing of this object of polishing is predicted using an indicator which indicates the height distribution of the above-mentioned polishing surface of the above-mentioned polishing body with reference to the above-mentioned substrate when no pressure is applied to this polishing body, as one of the parameters used in the calculations performed in this stage, and

the above-mentioned indicator is one indicator or a combination of two or more indicators selected from a set comprising the number of times that a dressing process is performed on the above-mentioned polishing body, the cumulative time of the dressing processes performed on the above-mentioned polishing body, the number of times that polishing is performed on the above-mentioned object of polishing by the above-mentioned polishing body, and the cumulative time of the polishing that is performed on the above-mentioned object of polishing by the above-mentioned polishing body.

30. The computer-readable recording medium according to Claim 29, which is characterized by the fact that in cases where a judgement of "unacceptable" is made in the above-mentioned judgement stage, the above-mentioned control parameter or control program preparation processing changes the above-mentioned assumed or set control parameters or control program to control parameters or a control program which are altered at least in part with respect to the control parameters or control program already judged to be "unacceptable" in the above-mentioned judgement stage, and the above-mentioned simulation stage and above-mentioned

judgement stage are repeated in that order until the control parameters or control program obtained are judged to be "acceptable."

31. A polishing system which comprises

a polishing apparatus that polishes an object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body, and

a control parameter or control program preparation apparatus which prepares control parameters or a control program used to control the above-mentioned polishing apparatus,

this polishing system being characterized by the fact that the above-mentioned control parameter or control program preparation apparatus includes (a) assuming means for assuming control parameters or a control program to be used in a simulation in accordance with the target distribution of the amount of polishing, (b) simulation means for predicting the distribution of the amount of polishing of the above-mentioned polished surface (that is obtained after the above-mentioned object of polishing has been polished by the above-mentioned polishing apparatus) by the simulation method according to Claim 1 using the parameters assumed by the above-mentioned assuming means, and (c) judgement means for judging the acceptability of the control parameters or control program assumed by the above-mentioned assuming means by comparing the distribution of the amount

of polishing predicted by the above-mentioned simulation means and the above-mentioned target distribution of the amount of polishing, and

the above-mentioned polishing apparatus polishes the above-mentioned object of polishing in accordance with control parameters or a control program prepared by the above-mentioned control parameter or control program preparation apparatus.

32. A polishing system which comprises

a polishing apparatus that polishes an object of polishing by causing relative motion between this object of polishing and a polishing body that is supported by a substrate while applying a load between this object of polishing and the above-mentioned polishing body, and

a control parameter or control program preparation apparatus which prepares control parameters or a control program used to control the above-mentioned polishing apparatus,

this polishing system being characterized by the fact that the above-mentioned control parameter or control program preparation apparatus includes (a) assuming means for assuming control parameters or a control program to be used in a simulation in accordance with the target distribution of the amount of polishing, (b) simulation means for predicting the distribution of the amount of polishing of the above-mentioned polished surface (that is obtained after the above-mentioned object of polishing has been polished by the above-mentioned polishing

apparatus) by means of the simulation apparatus according to Claim 12 using the parameters assumed by the above-mentioned assuming means, and (c) judgement means for judging the acceptability of the control parameters or control program assumed by the above-mentioned assuming means by comparing the distribution of the amount of polishing predicted by the above-mentioned simulation means and the above-mentioned target distribution of the amount of polishing, and

the above-mentioned polishing apparatus polishes the above-mentioned object of polishing in accordance with control parameters or a control program prepared by the above-mentioned control parameter or control program preparation apparatus.

33. The polishing system according to Claim 31, which is characterized by the fact that in cases where a judgement of "unacceptable" is made in the above-mentioned judgement stage, the above-mentioned control parameter or control program preparation apparatus changes the above-mentioned assumed or set control parameters or control program to control parameters or a control program which are altered at least in part with respect to the control parameters or control program already judged to be "unacceptable" by the above-mentioned judgement means, and this polishing system includes means for causing the above-mentioned simulation means and the above-mentioned judgement means to repeat their operations in that order until the control parameters or control program obtained are judged to be "acceptable."

34. The polishing system according to Claim 32, which is characterized by the fact that in cases where a judgement of "unacceptable" is made in the above-mentioned judgement stage, the above-mentioned control parameter or control program preparation apparatus changes the above-mentioned assumed or set control parameters or control program to control parameters or a control program which are altered at least in part with respect to the control parameters or control program already judged to be "unacceptable" by the above-mentioned judgement means, and this polishing system includes means for causing the above-mentioned simulation means and the above-mentioned judgement means to repeat their operations in that order until the control parameters or control program obtained are judged to be "acceptable."

35. The polishing system according to Claim 32, which is characterized by the fact that the input of the control parameters or control program prepared by the above-mentioned control parameter or control program preparation apparatus into the above-mentioned polishing apparatus is performed automatically or in response to commands.

36. The polishing system according to Claim 32, which is characterized by the fact that the input of the control parameters or control program prepared by the above-mentioned control parameter or control program preparation apparatus into

the above-mentioned polishing apparatus is performed automatically or in response to commands.

37. The polishing system according to Claim 31, which is characterized by the fact that the polishing of the above-mentioned object of polishing is chemical mechanical polishing which is performed with a polishing agent interposed between the above-mentioned polishing body and the above-mentioned object of polishing.

38. The polishing system according to Claim 32, which is characterized by the fact that the polishing of the above-mentioned object of polishing is chemical mechanical polishing which is performed with a polishing agent interposed between the above-mentioned polishing body and the above-mentioned object of polishing.

39. A semiconductor device manufacturing method which is characterized by the fact that this method has a process in which the surface of a semiconductor wafer is flattened using the polishing apparatus according to Claim 24.

40. A semiconductor device manufacturing method which is characterized by the fact that this method has a process in which the surface of a semiconductor wafer is flattened using the polishing apparatus according to Claim 25.

41. A semiconductor device manufacturing method which is characterized by the fact that this method has a process in which the surface of a semiconductor wafer is flattened using the polishing apparatus according to Claim 26.

42. A semiconductor device manufacturing method which is characterized by the fact that this method has a process in which the surface of a semiconductor wafer is flattened using the polishing system according to Claim 31.

43. A semiconductor device manufacturing method which is characterized by the fact that this method has a process in which the surface of a semiconductor wafer is flattened using the polishing system according to Claim 32.